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EDWIN E. SLOSSON, Director
WATSON DAVIS, Managing Editor

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ARCHAEOLOGISTS BEGIN EXCAVATION OF MAYA CITIES

An archaeological expedition from the Carnegie Institution of Washington, headed by Dr. Sylvanus G. Morley has left New Orleans for Mexico to begin excavations of the buried cities of the ancient Maya empire in Yucatan near the port of Progresso.

Inauguration of a ten year program of archaeological research in cooperation with the Mexican government has been delayed by the recent political disturbances in Mexico, but arrangements were made with Dr. Manuel Gamio, director of the Mexican Bureau of Anthropology, during his recent visit to this country, to begin work immediately.

The party taking the field for preliminary investigations and excavations at Chichen Itza includes Dr. Morley, Earl H. Morris, archaeologist in charge of excavations, Monroe Amsden and O.G. Ricketson, Jr., assistant archaeologists.

As a result of preliminary explorations at Chichen Itza made last winter, it was decided to take up first the excavation of "The Group of the Thousand Columns", a section of the city composed of great colonnaded halls surrounding a plaza of more than five acres in extent.

Running out from this great colonnade there are smaller ones, composed, some of square columns, and others of round ones, and at various places around the enclosure there are lofty pyramids which were originally surmounted by elaborately decorated temples of dressed stone.

The luxuriant tropical vegetation which has sprung up since Chichen Itza was abandoned in 1448 A.D. has buried the city in a mantle of living green; roots have found their way deep into foundations and torn stone from stone, until the roofs have collapsed, and desolation reigns. No small part of the work of the Carnegie Institution excavators at Chichen Itza will be the removal of this luxuriant tropical forest which has done so much harm to the ancient edifices.

The city was founded in the fifth century of the Christian Era by a tribe of the Maya race called the Itza. The name means "Chi", "mouth", "chen", "wells", "Itza" the name of the tribe which founded the city: "The mouths of the wells of the Itza".

This name was given to the place because of two great natural wells which

are there, and which afforded an inexhaustible water supply in a land which is conspicuous for the absence of surface or flowing water. It is not too much to say that the presence of two such wells at one place pre-determined under primitive conditions that a large center of population should one day grow up around them.

One of these wells was used as a source for the water-supply of the city; the other as a place of sacrifice wherein the mostbeautiful maidens of the tribe were hurled in times of great drought as sacrifices to the offended rain deities. Today the vast courts and colonnades, the lofty pyramids and spacious palaces, the temples and terraces, are silent; a great forest has overgrown them and overthrown them.

It is in these remote solitudes, that the ringing sound of the ax, pick and shovel of the excavator will soon be heard, and the intensive study of this former metropolis of ancient America will be commenced.

CHICAGO MUSEUM DIGS NEAR SITE OF BABYLON

Important information regarding the cradle of civilization in Mesopotamia is expected by the Field Museum of Natural History from the joint expedition of the Museum and Oxford University, now at work excavating the ancient capital of Sumer and Akkad, eight miles east of the site of the city of Babylon. The work is in charge of Dr. Stephen Langdon of Oxford.

This expedition is only one of four now in the field, Dr. D. C. Davies, director of the Museum, announced today. E.S. Riggs and members of the paleontological expedition are looking for fossils in Argentina, while C.C. Sanborn is in Chile, collecting birds and mammals. Edmund Heller, who was one of the leading members of the Roosevelt expedition to Africa in 1909, is again in that country heading a party in search of game animals near Lake Tanganyika. W.J. Morden is collecting game animals in southern Asia and a party under H.B. Conover is collecting specimens of game birds in Alaska.

BALLOON TORN FROM GROUND CARRIES SCIENTIST INTO STORM

The U.S. Weather Bureau's storm sleuth extra-ordinary, Dr. C.L. Meisinger, ended his fifth thrilling voyage from Scott Field, Illinois, April 29, at ten o'clock at night when rain forced down his balloon three miles southwest of Hartsburg, Missouri, and a quarter of a mile from the Missouri River.

Dr. Meisinger and his pilot, Lieut. James T. Nealy of the U.S. Army, left Scott Field suddenly when a gust of wind tore their balloon from the hands of assistants on the ground and carried it bouncing across the field for a quarter of a mile before it started up.

The balloon took off in a south wind at 2:55 p.m. This changed to southeast, and east as an altitude of between four and five thousand feet was reached. Carried westward over Missouri, the balloonists encountered snow and rain. The rain finally forced down the big gas bag which landed safely in the dark at 10. p.m. in a northwest wind.

Dr. Meisinger spent the rest of the night asleep in the basket of his balloon three miles from town.

METEOROLOGISTS FAVOR REFORM OF THE CALENDAR

Reform of the calendar, with a year to consist of 13 months of four weeks each with one "extra" day, was advocated by a resolution passed by the American Meteorological Society in recent session here. The change was urged by Dr. C.F. Marvin, chief of the U.S. Weather Bureau, on the ground that it would simplify the collection and study of weather data.

Dr. Marvin said the whole question of the reform of the calendar was before a special committee of the League of Nations, and the resolution approved by the meeting directed the secretary of the society to notify the League committee of the society's action. Dr. Marvin added that January 1, 1928 had been tentatively chosen as the most favorable time for a number of years to come on which to start the new calendar, since that year begins on Sunday.

By the proposed calendar, every month would be just four weeks long, the same day of every month would always fall on the same day of the week, and religious and secular days such as Easter and Election Day would always come on t the same day of the year. A committee on which all the great religions of the western world are represented is now conferring with the League of Nations committee on this subject.

PREDICTING THE MOVEMENTS OF ELECTRONS

By Dr. Edwin E. Slosson.

The essence of science is prophecy. Until a student of nature can tell what is going to happen beforehand his knowledge is of uncertain validity and little value.

The science of astronomy had its birth twenty-five hundred years ago when the Greek philosopher, Thales, predicted the coming of an eclipse of the sun.

Today a new science is being born, quite as marvellous as astronomy and much more important to the world. It may indeed be called "the astronomy of the atom", since it deals with the orbits of the electrons in their revolution about the central nucleus. This reminds us of the arrangement of the solar system with the positively charged nucleus standing for the sun in the center and the corpuscles of negative electricity revolving around it. But there is this important difference. The solar system is stable and the planets pursue almost exactly the same course, century after century, fortunately for us who are living on one of them. It would be decidedly disconcerting to us, if, for instance, Mars should be carried off by a comet, making the grand tour of the universe, and Saturn should suddenly drop into its place. Or if our earth should be detached from the sun and swept off through space and be drawn into the sphere of influence of some other star like Sirius, which we might not like so well as our own sun. Yet that sort of thing happens frequently with the electronic planets

inside the atoms. And it has now been found possible to predict what particular orbit a loosed electron will fall into. This is possible because when an electron shifts from an outer orbit to one nearer the nucleus it sends out a flash of light of a definite color, that is to say the waves of the emitted light are of a certain length and a corresponding frequency. The "frequency" means the number of waves passing a given point in a second. The longer the waves, of course, the less the frequency. The frequency and wave length of the light radiated by any star or incandescent gas can be determined by the location of the bright lines in its spectrum.

Prof. R.A. Millikan of the California Institute of Technology has recently discovered a way of stripping off one by one the outer electrons from an atom and he can tell in advance with amazing accuracy just what sort of light will be emitted by such a stripped atom. Last year Dr. Millikan was awarded the Nobel Prize in physics for the ingenious piece of apparatus that enabled him to catch and count the loose electrons and calculate their electric charge. He has this year penetrated still further into the mystery of atomic structure. His new discovery was to have been explained to the National Academy of Sciences on the afternoon of April 29, but on account of the tragic death of Dr. E.F. Nichols while addressing the Academy that morning no further papers were read during the day. But Professor Millikan has kindly consented to give Science Service a plain account of what he has done and what it means.

THE ASTRONOMY OF THE ATOM

By Dr. Robert A. Millikan,
California Institute of Technology.

The world is just entering upon a period of development of atomic mechanics, or of the astronomy of the atom, which has many points in common with the period of development of celestial mechanics which occupied the two or two and a half centuries following Galileo. Celestial mechanics was made possible through the invention of the telescope. The spectroscope bears precisely an analogous position with respect to atomic mechanics. The telescope made it possible to determine the exact orbits of heavenly bodies and to check by precise observation of such phenomena as the time of eclipses the theoretical results which are consequences of the Newtonian laws. Similarly, today the spectroscope has furnished the physicists with means for the quantitative testing of the recently developed laws of atomic mechanics, and it is today furnishing as exacting proof of the orbital theory of electronic motions as the telescope furnished a century earlier for the orbital theory of the motions of heavenly bodies.

The present paper shows not merely what kind of phenomena can be predicted with the aid of the orbital theory of electrons and atoms, but with what amazing precision these predictions are verified by the test of experiment. These results have been made possible because of the development of high vacuum "hot spark" spectrometry with the aid of which we were able first in 1920 to push three or four octaves farther into the ultra-violet than preceding investigators had gone. For the sake of simplicity, I shall at first confine attention to the radiations emitted by one particular atom, namely, the atom of boron, familiar to every household because of the abundant use of boracic acid for disinfecting purposes.

The atom of boron is the fifth in the order of increasing atomic weights,

hydrogen being the lightest, helium the next, lithium the next, beryllium the next, and boron the next. This means that the nucleus of the boron atom contains five free positive electrons and that five negative electrons are held outside the nucleus, or just enough to make the normal boron atom electrically neutral. Of these five electrons, two have been proved heretofore, and are again proved in this paper, to be close to the nucleus. The remaining three are four or five times more remote from the nucleus and are called its valence electrons. For the sake of later comparison it is useful to recall that lithium possesses one of these valence electrons, beryllium, two, boron three, carbon four, nitrogen five, oxygen six, and fluorin seven, which is the highest number possessed by any known atom having the possibility of combining with other atoms at all.

Now the interesting property of our hot sparks, which are very high potential discharges in the highest vacua between electrodes from a fraction of a millimeter up to one or two millimeters apart, is that such hot sparks possess an extraordinary ionizing power. Mr. I.S. Bowen and myself at the California Institute of Technology have recently definitely proved that these hot sparks have the power of stripping a great many atoms completely of all their valence or outer electrons. These stripped atoms of lithium, beryllium, boron, carbon, and nitrogen, for example, are then completely similar atomic structures, save for the fact that the central charge increases in the ratios one, two, three, four, five in going from lithium to nitrogen. This is the first time that it has become possible to compare the radiating properties of such a long series of similar atomic structures and the discovery of a means of obtaining such a series has furnished the opportunity of getting some very interesting checks upon the theory of electronic orbits.

Now the theory of electronic orbits in atoms is similar to the theory of planetary orbits in astronomy save that the atoms have one restriction unknown to the former. While celestial mechanics permits of the existence of as many orbits as you please around a given central sun, atomic mechanics permits of a very limited number of orbits whose radii progress (in the simple Bohr theory) in the ratio of the squares of the numbers one, two, three, four, five, etc. Atomic mechanics also differs from celestial mechanics in the mechanism by which the existence of a particular orbit can be experimentally tested. Thus, the most exact test which astronomy offers for the correctness of hypothetical planetary orbits is the prediction of the instant of passage of two such orbits through a given line so as to produce an eclipse. If the eclipse occurs at the predicted instant, it is considered that the theory which made the predictions possible has received extraordinary quantitative support. In the astronomy of the atom, on the other hand, we cannot observe an eclipse, but what we do observe is the frequency (the reciprocal of the wave-length) of the radiation emitted when an electron jumps from one of its possible orbits to another. These jumps always occur from the orbits more remote from the nucleus to those which are closer to it and the difference in the energies of the electrons in the two orbits (which I shall call the energy of the orbit itself) is found to be in every case exactly proportional to the frequency emitted. It is this frequency which the spectroscope immediately brings to light as a spectral line whose wave length and therefore whose frequency, it enables us very accurately to measure.

The whole number of different orbits which are possible in such a simple nucleus-electron-system as is furnished by the hydrogen atom has long been accurately known experimentally, and these known orbits have been fitted beautifully and accurately into what is known as the simple Bohr theory.

This theory requires that if the charge on the nucleus should be successively given the values one, two, three, four, five, the frequencies of all of the orbits would be increased in the ratios one, four, nine, sixteen, twenty-five. Now thediscovery of the possibility of stripping all the valence electrons off the atoms of lithium, beryllium, boron, carbon, and nitrogen has given us the means of comparing the radiations from what are in effect simple nucleus-electron-systems in which the charge on the nucleus increases in the ratios one, two, three, four, five, provided always that we are comparing orbits in different atoms which are so remote from the nucleus that the pair of electrons which, as indicated above, is near the nucleus in all the atoms may be considered as exerting their forces as though they were in the nucleus itself.

To return now to the consideration of the stripped boron atom. When Mr. Bowen and I began to get evidence that our hot sparks were stripping the boron atoms of all their valence electrons we set to work to predict exactly what sort of frequencies (or of wave lengths) we might expect to be emitted by the stripped boron atoms as a single electron, in being drawn into this stripped atom, began to jump between the possible orbits which ought to exist about it. Thus, on the basis of our knowledge of the spectral lines emitted by hydrogen, we predicted at once that an electron in jumping from the fifth to the fourth of these possible orbits would produce a line of just nine times the frequency of the radiation produced when the hydrogen atom electron jumped from the fifth to the fourth orbit. We computed in this way that this stripped boron atom ought to have a line whose wave length was 4500 Angstrom units, that is, a line in the blue region of the ordinary visible spectrum. No such line had ever been observed with boron thus far, but no one had before worked with light like that given off by our hot sparks which one could expect would produce stripped boron atoms. So we made our exposure, developed our plate, and found our predicted line which no one had ever seen before at exactly the wave length 4499.0, or within one part in 5000 of the predicted spot. In other words, our predicted "eclipse" in the field of astronomical orbits had occurred at exactly the right time.

We also computed the radiation that would be produced when the electron circling around the stripped boron atom fell from the third orbit to the second and got 678 angstroms. We looked up our table of boron lines in the extreme ultra-violet which we had published last January and found that we had recorded a strong line at wave length 677 angstroms, but if this were indeed due to the stripped boron atom it ought to be, like the so-called D line of sodium, a doublet, that is, a pair of lines very close together. It had not appeared so on our old plate, but the spectrograph had not been one which could have separated this pair, even if it existed, so we built a new spectrograph of higher resolving power and took another photograph of this line and found that it was indeed a doublet just as our orbit theory demanded, the two components of which had wave lengths of 677.01 and 677.16.

We have now brought to light all of the lines which were to be expected from the stripped boron atom and by checking all of these predictions by experiment we had proved with absolute certainly that in our hot sparks we were producing stripped boron atoms.

But someone says: Are these resutlts dependent upon your orbit theory ofthe motion of electrons? Thus far, not completely, but in the next stage they are completely so dependent. I have spoken of the doublets which

we found produced by the stripped boron atom. Now the principal lines in the spectrum of hydrogen are also doublets and a beautiful theory was developed by Professor Sommerfeld for explaining these doublets. He showed that there ought to be two orbits, one circular and one elliptical, which would have exactly the same energy if it were not for the fact that the mass of the electrons in the elliptical orbit should grow greater as its speed increased in going through perihelion and smaller as it went through aphelion, and that because of the dependence of mass upon speed which is required by the Einstein theory of relativity. He further computed exactly with the aid of that theory the differences in the energies of two orbits, the one circular and the other elliptical, and found that this theory, which yielded a formula in which there were no undetermined constants at all, predicted completely and exactly the observed frequency separation of the hydrogen doublet. We now tried this relativity doublet theory upon the doublets which we had found in lithium, beryllium, boron, and carbon, and found that this purely theoretical formula predicted exactly the observed separations in all cases. We then predicted from this formula the separation of the doublet which ought to be produced by the stripped nitrogen atom and looking in the nitrogen spectrum found a nitrogen doublet with precisely the correct separation and at a wave length which we could also predict by our theory. We had thus brought to light a most powerful instrument with which we can now alanyze the light that comes from any kind of a source, for example, a very hot star, and know at once by comparison with the theory of observed lines whether stripped atoms of a whole series of substances exist or do not exist in the sources. In this way, we have definitely proved the existence in our hot sparks of stripped atoms of lithium, silicon, phosphorus, and sulphur, this last atom having been stripped of six valence electrons, phosphorus of five, silicon of four, aluminum of three, magnesium of two, and sodium of one.

These methods bring to light new ways of going on eclipse expeditions in the study of the astronomy of the sub-atomic world and they reveal new possibilities for the reading of the conditions existing in the stars. Truly, we are just now entering upon a period of the fascinating study of the astronomy of the atom, a period in which the spectroscope is the instrument with which we must bring to light wonders no less fascinating than those which the telescope has revealed in the study of the stars.

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ASTRONOMERS DEBATE EINSTEIN'S SHIFT OF SOLAR SPECTRUM

Einstein's third prediction, that the spectrum of the sun is shifted slightly toward the red end as compared with light from the earth, is not borne out by experimental evidence presented to the National Academy of Sciences at its annual session at Washington, by Dr. Heber D. Curtis, director of the Allegheny Observatory, Pittsburg.

This negation of one of the important points in the Einstein theory of relativity stirred the scientists gathered here because Dr. Charles E. St. John of the Mount Wilson Observatory, California, at the same session presented evidence in favor of Einstein's prediction of the effect of the gravitational field of the sun upon the light emanating from it. Dr. St. John made a preliminary announcement upholding Einstein last fall.

Dr. Curtis explained that the very minute shift toward the red end of the spectrum required by the Einstein theory amounted to only about eight thousandths of an Angstrom unit, roughly two one-millionths of the wave-length of the light.

The accuracy of the measurements made by Dr. Curtis with cooperation of Dr. Kelvin Burns of his staff and Dr. W. F. Meggers of the National Bureau of Standards is more than ten times that of this predicted shift. The apparatus used was a combination of an interferometer with a powerful grating spectrograph applied for the first time to a systematic investigation of the solar spectrum.

The measurements show shifts of the spectrum, but they are of a complex nature rather than the simple and uniform amount predicted by the relativity theory, Dr. Curtis announced.

"Instead of all the solar lines being shifted by an equal amount to the red," Dr. Curtis said, "and instead of that amount being the quantity predicted by Einstein's theory, a very marked line-intensity factor is found. For the very faint solar lines there is little, if any, shift, and the amount of this shift increases as the wider and stronger lines are used."

For a solar line of very weak of 0 or 1 intensity the shift to the red amounted to only two ten-billionths of a millimeter, while Einstein's prediction calls for a shift of eight ten-billionths of a millimeter. In the case of very strong lines of those of 15 intensity, the shift was nearly double that predicted by Einstein, or fifteen ten-billionths of a millimeter. (A ten-billionth of a millimeter is one one-thousandth of an Angstrom unit.)

"There is thus seen to be an unmistakable progression in this shift, which must be due to some factor or factors other than relativity, and it does not seem possible to reconcile these results with that theory," Dr. Curtis concluded. "For the theory requires that all solar lines be shifted to the red by a certain amount, while our results showthat the very weak solar lines are shifted only a quarter or less of that amount. That is, if the relativity prediction is true, we must postulate some cause to shift the very weak lines back toward the violet. Now, while various causes may shift spectrum lines to the red, there is no known case of anything shifting them to the violet, except velocity, which seems untenable in this case."

On the other hand, Dr. St. John holds that the shifting of the lines of the solar spectrum are in the main satisfactorily accounted for by the Einstein theory of relativity, and that the minor deviations from the theoretical displacement observed in the rays coming from the high and low levels of the solar atmosphere are due to the motion of the currents of the hot gas. In the outer atmosphere the cooler vapors, which are settling downward, and therefore drifting away from us, cause a shift of the lines toward the red, in addition to the Einstein effect. While in the lower levels of the sun's atmosphere, three-fourths of the light is emitted by the hotter rising gases, and this motion toward the earth produces a shift toward the violet which tends to reduce the Einstein effect. Recent observations made on Mt. Wilson show that there are up-

ward and downward convection currents of incandescent gases in the stars, like those in the sun, but of vastly greater velocity.

AN UNFINISHED PAPER

By Dr. Edwin E. Slosson.

At the moment when he was completing his demonstration of new radio waves Ernest Fox Nichols fell back upon the exedra in the rotunda of the new building of the National Academy of Sciences. His wife rushed to his side with restoratives, but in vain, for a few minutes later, President Michelson announced his death, and the adjournment of the session of the A cademy. Shorthly after, the Academicians were walking in procession down the marble steps through the newly planted garden following the body of their distinguished colleague.

Professor Nichols had died as he had lived, in the active promotion of science. Research was his life work, and although he had twice been tempted into administrative office, by serving as president of Dartmouth College from 1909 to 1916, and by accepting an appointment to the presidency of the Massachusetts Institute of Technology in 1921, he gladly returned again to his investigation of the laws of light.

Visible evidence of his ability as an experimenter was close at hand for while he was yet speaking visitors in a room next to the rotunda were examining the apparatus with which he proved the pressure of light. By touching a button of this ingenious mechanism, one can turn on an electric lamp and actually see for himself that the beam of light exerts a definite pressure upon whatever object it strikes. This pressure is so minute that it had never been observed until Prof. Nichols demonstrated it twenty-four years ago. Yet as we now know the sunlight falling daily upon the earth amounts to a weight of more than 100,000 tons. It is this light pressure that makes the tail of a comet by driving the infinitesimal dust particles away from the sun. It is also light pressure that keeps the gaseous stars like Betelgeuse swelled out to their gigantic size in opposition to the attraction of gravitation tending to draw them together into a solid mass. The actual demonstration of the fact that light produced a pressure effect was of especial importance, since it is involved both in Maxwell's theory of the similarity of electrical and light waves and also in Einstein's more recent theory of relativity.

The life of Ernest Fox Nichols was cut short at fifth-five, yet few of his elder colleagues in American science have accomplished more. He was born in Leavenworth, Kansas, and being early left an orphan, was brought up by his uncle, General Fox. He went first to the Agricultural College at Manhattan, Kansas, and afterwards studied at Cornell, Cambridge and Berlin. At Berlin University, under Professor Rubens, be began his work on the long wave lengths about which he was talking when he died. While professor of physics at Dartmouth, he developed a radiometer of such delicacy that he was able to measure the heat that comes to us from the stars. In his last paper he was engaged in closing in the "missing link" between the longest of the heat waves and the shortest of the radio waves thus completing the series of the spectrum which runs from the "gamma rays" of radium, which are a hundred thousand times shorter than light waves, to the "wireless waves" which are miles in length.

It would seem almost that he had a premonition that he would not complete his paper, for he began by saying that he would reverse the usual order of procedure and present his conclusions at the beginning. So he showed his last slide first. His auditors assumed that he did this in order to avoid being interrupted by the president before he had completed his demcnstration, as speakers often are. His paper, was, indeed, left unfinished as he feared, but it e was a higher power than the president of the Academy who notified him of the expiration of his allotted time.

A PIN FALLS

A pin was dropped on a desk by a speaker at the dedication of the new building of the National A cademy of Sciences and the National Research Council in Washington. That pin-fall was perhaps the most significant and widely heard of any in all history. Without being warned to silence, every person in the high-domed, wide-winged hall plainly heard the pin as it struck the woodwork. Thousands of radio listeners, hundreds of miles away, also heard. Specially designed artificial stonewalls made the sound clear, distinct, without those hollow echoes which characterize high vaulted buildings of the past. That pin fall sounded an engineering triumph in the long-neglected science of acoustics.

SAVING BABY'S NECK

Eradication of tuberculosis among cattle is saving the necks of babies, literally saving their necks. According to Dr. James S. Stone of Boston who gave a public lecture at the Harvard Medical School, the condition formerly called scrofula in infants is on the decrease. This so-called scrofula was really a tubercular infection of the tonsils and lymph glands of the neck. The infection was the cattle type and the babies got it in their milk. Pasteurization of the milk and the fight against the disease in cattle now makes the milk supply safer. But, Dr. Stone warns, much remains to be done. The danger comes suddenly when tuberculosis develops in the udder of any cow, thus permitting the tubercule bacilli to pass directly into the milk.

VIOLINS

Old Italian violins used to be the despair of modern manufacturers. They could make nothing just as good. Then it was discovered that there was something in the wood of the instruments made by the old masters which gave the wood a hornlike structure. Working on this clue, a scientist found that treating the wood of violins with easily drying oils gave it the same appearance as the famous Italian fiddles. Putting the matter to the tests, new violins were found not only to look like those of the masters but to sound equally as well.

A frog raised from eggs which were never fertilized by a male frog is on exhibition in the new Academy of Sciences Building in Washington.
